(12) UK Patent Application (19) GB (11) 2 337 672 (13) A

(43) Date of A Publication 24.11.1999

(21) Application No 9810810.3

(22) Date of Filing 20.05.1998

(71) Applicant(s)
3Com Technologies
(Incorporated in the Cayman Islands)
PO Box 309, Upland House, Georgetown,
Grand Cayman, Cayman Islands

(72) Inventor(s)
Nigel Horspool
Paul James Moran
David John Law
Paul Cramphorn

(74) Agent and/or Address for Service
Bowles Horton
Felden House, Dower Mews, High Street,
BERKHAMSTED, Herts, HP4 2BL, United Kingdom

(51) INT CL^6
H04L 1/12

(52) UK CL (Edition Q)
H4P PEM

(56) Documents Cited
GB 2277237 A US 5524122 A

(58) Field of Search
UK CL (Edition P) H4P PEM PEV
INT CL^6 H04L 1/00 1/12 1/16 1/20
Online Database: WPI

(54) Abstract Title
Reducing the data rate when idle state symbol errors exceed a threshold

(57) Data can be transmitted between an Ethernet network hub and an end station at a plurality of different data rates, the rate being selected by an auto-negotiation process. The data connection is maintained in the absence of meaningful transmitted data by the transmission of a continuous sequence of 'idle state' symbols. The occurrence of errors represented by a non-idle state symbol immediately followed by an idle state symbol is monitored. When the rate of occurrence of errors exceeds a threshold the data connection is forced to proceed at a lower data rate.

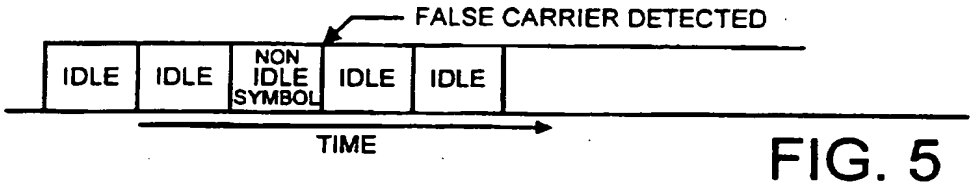

FIG. 5

GB 2 337 672 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

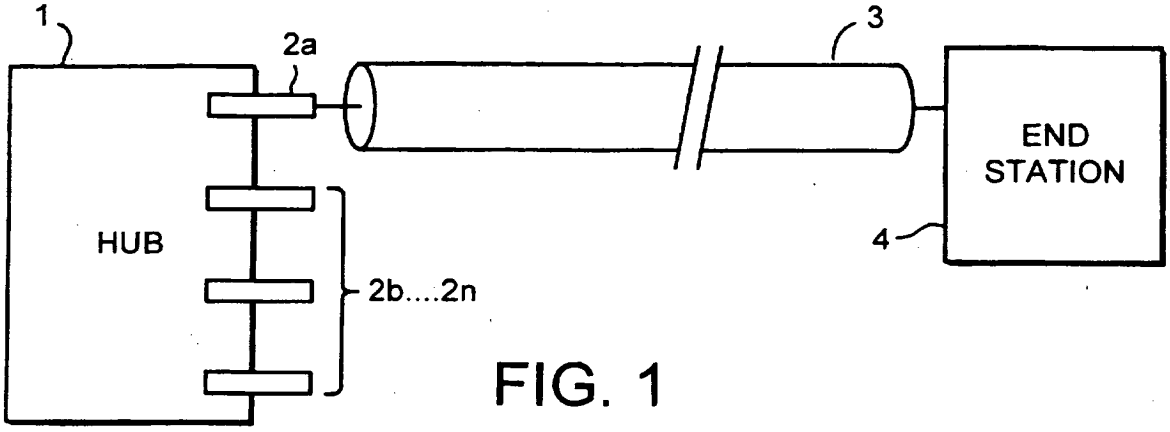

FIG. 1

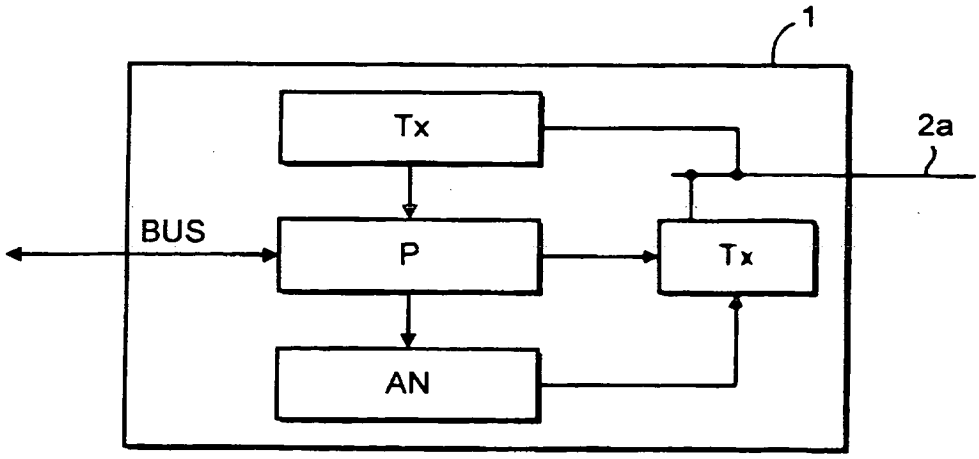

FIG. 2

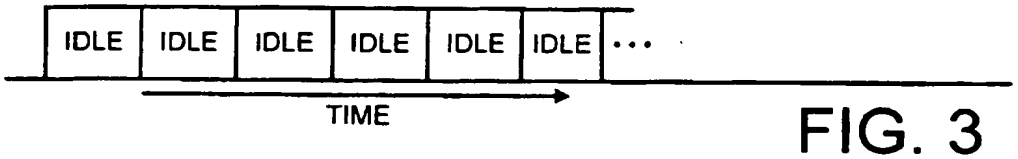

FIG. 3

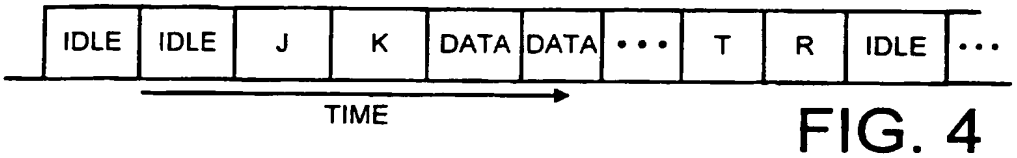

FIG. 4

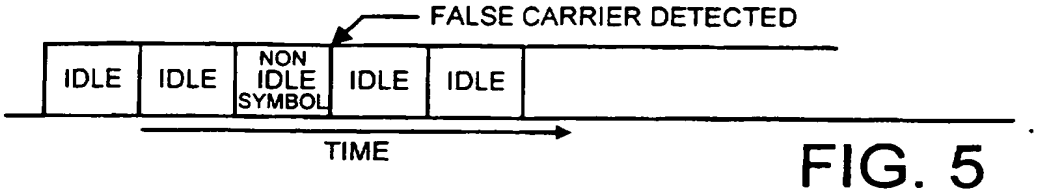

FIG. 5

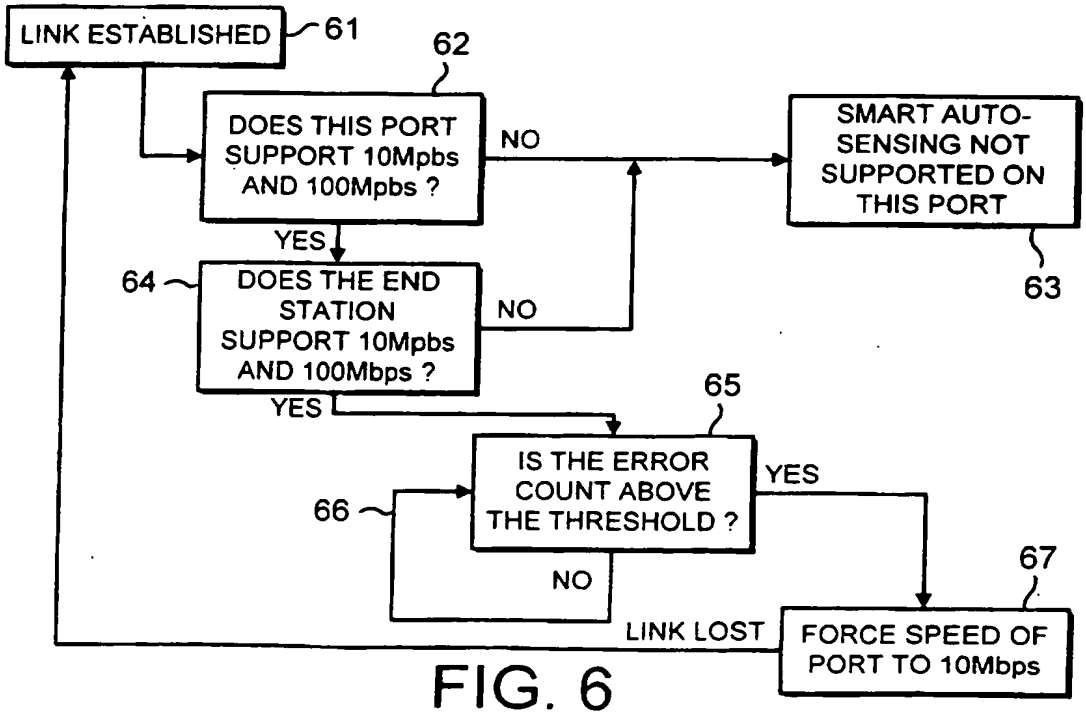

FIG. 6

MONITORING OF CONNECTION BETWEEN AN ETHERNET HUB AND AN END STATION

FIELD OF THE INVENTION

This invention relates to packet-switched data communication networks, and particularly an Ethernet network or similar network wherein data may be transferred between a hub and another network station (particularly an end station such as a personal computer, at least two different rates, the hub and the other network station being able to establish a selected data rate by means of auto-negotiation. The invention is particularly though not necessarily exclusively intended for use with an auto-negotiation scheme as defined in IEEE 802.3u.

BACKGROUND OF THE INVENTION

As switching and other technology has improved, the rate at which data may be transferred between network devices has increased. Currently there are various standards to which successive generations of network devices have been designed to operate. In particular, a standard data rate of 10 megabits per second has been partly planted by a standard of 100 megabits per second and is expected to be supplanted by an even faster rate, 1000 megabits per second. However, network devices operating according to obsolescent standards (i.e. the lower data rate) continued to be used. It therefore follows that it is known for a network hub to be capable of exchanging data with another network station at a plurality of different selectable rates. It is also known, and specified in for example in the above mentioned network standard, for a hub and a station to which it is connected to commence a "conversation" by a process of "auto-negotiation", wherein a network hub establishes by means of interrogation and response whether the other station is capable of transmitting and receiving data at the higher of two rates (or a rate which is practically the highest of a multiplicity of rates) so that thereafter the hub and the other station exchange information or transmit information from one to the other at the selected higher or highest rate.

It is also known to maintain a connection between a hub and another station by means of a continuous sequence of symbols representing an "idle" state. When one station at either end of the connection wishes to send data then by convention it sends at least a first symbol followed by a second symbol, representing a "carrier" signal. The data then follows in the format defined by the appropriate standard. At the end of the data packet a third predetermined symbol followed by a fourth predetermined symbol is sent, so as to represent the end of the carrier. Such a sequence is conventionally repeated for each and every packet transmitted between the stations.

BRIEF SUMMARY OF THE INVENTION

The present invention particularly relates to systems of this character and is concerned with a process for use with an auto-negotiation process, to monitor the quality of the connection, particularly a cable connecting a port on the hub to an end station.

If a multi-speed connection is used with badly installed cable or a cable or other link which does not meet an appropriate performance specification, then the reliability and throughput of the connection will be much reduced. The object of the present invention is to detect, by the monitoring of specific errors, the quality of the connection and, should the error rate representing a parameter of the quality of the cable exceed some selectable threshold, to cause the reduction of the data rate for the connection to a lower rate.

The present invention is based on the detection of the corruption of isolated idle symbols into a first symbol which would normally indicate the start of a data packet but is identifiable as an error when followed by an idle symbol. This specific form of error, known as false carrier and by convention written "FalseCarrier", may be used as a reliable parameter of the quality of a connection between a hub and an end station in accordance with the invention.

In a preferred form of the invention, the method may be implemented on a 10/100 megabit per second hub repeater that uses auto-negotiation, as defined in IEEE 802.3u, to determine the data rate for a connection between the hub repeater and an end station. The 100 megabit per

second connection transmits a sequence of "idle" symbols to establish and maintain the link between the repeater and the end station. If these symbols are corrupted and the error rate of the false carriers increases above a certain threshold then the link may be downgraded to a data rate of 10 megabit per second.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates schematically a hub connected to an end station;

Figure 2 is a schematic representation of certain operational functions within the hub;

Figure 3 illustrates a sequence of "idle" symbols;

Figure 4 illustrates a sequence of symbols representing the transmission of a data packet;

Figure 5 illustrates the occurrence of a "falsecarrier" error; and

Figure 6 is a flow diagram illustrating the operation of the invention.

DETAILED DESCRIPTION OF PREFERRED EXAMPLE

Figure 1 and Figure 2 illustrate schematically, as indicated previously, a hub connected to an end station and certain operational functions within a hub. The representation is schematic only, because hubs such as Ethernet hubs operating according to a dual standard such as 10/100 megabits per second are well known in the art and the process of auto-negotiation is also well known, being defined in the aforementioned IEEE standard.

Figure 1 illustrates therefore an Ethernet hub 1 having a plurality of ports 2a, 2b...2n, to which port 2a is shown as connected by way of a cable connection 3 to another network station, particularly an end station such as a personal computer 4. The hub 1 may have many connections to other end stations, but each of these is an independent point to point link. The

hub may be a stackable hub composed of a multiplicity of stacked hub units disposed to form a single logical entity whereby data received at any port on any of the units may be transmitted from any other port on any of the stacked units.

Figure 2 illustrates in greatly simplified manner some of the functions associated with at least one of the ports. These functions may be exerted by processing means common to a multiplicity of the ports or may be individual to each port. For the sake of simplicity, since Figures 1 and 2 represent known practice the representation in Figure 2 does not follow the complex though well known architecture and processing protocols associated with Ethernet repeater hubs.

Broadly, associated with the bi-directional port 2a is a receiving function RX, a data processing function DP, various other functions (not illustrated for convenience), an auto-negotiation function AN and a transmit function TX under control of both the data processing function and the auto-negotiation. The data processing function is shown with a connection to a bus BUS that may convey data elsewhere in the hub, for example to other ports.

It is now presumed, in accordance with known practice, that the hub is capable of sending and receiving data from port 2a at any one of a plurality of different rates. For the sake of simplicity will be presumed that the rates are 10 megabits per second and 100 megabits per second. Obviously, if the end station were capable of transmission and reception only at the lower rate, the present invention would not apply. However, it is further presumed that the end station is capable of operation, namely data transmission and reception, at both a lower rate (10 megabits per second) and a higher rate, 100 megabits per second. The present invention would also be applicable where for example the repeater were capable of operating at three different rates and the end station were capable of operating at at least two or possibly three of those rates.

It is known, as indicated in the foregoing, for the hub to establish by interrogation of and response from the end station whether the end station is capable of operating at the higher of two rates and thereafter to cause the exchange of information at the higher rate.

It is customary to maintain a connection by the transmission of a continuous sequence of symbols representing an idle state, as shown in Figure 3. When either of the stations wishes to send data, it is then conventional for the end station to transmit a first predetermined symbol, and particularly a J-symbol, followed by a second predetermined symbol, particularly a K-symbol. The transmission of these two symbols in immediate sequence represents a "start of carrier", and are the conventions digital version of what was originally an actual carrier wave in analog networks. The data then follows, particularly as defined in the aforementioned IEEE specification. At the end of the data packet a third predetermined symbol, particularly a T-symbol, is immediately followed by a fourth predetermined symbol, particularly an R symbol. These two immediately successive symbols represent the "end of carrier". The sequence is repeated for each and every package transmitted.

The transmission of a data packet following and preceding a sequence of idle symbols is shown in Figure 4. Symbols J and K are followed by the data symbols, which are followed by the T and R symbols whereupon the transmission reverts to a continuous sequence of idle symbols.

If the link between the stations is badly installed or is of inadequate performance specification then the symbol stream is liable to be corrupted. This is shown in Figure 5, wherein a "non idle" symbol has been transmitted, being an idle symbol corrupted to some other symbol.

Figure 6 represents a flow diagram of a programme which may readily be implemented in the data processing function of a hub repeater as shown in Figures 1 and 2. It is presumed that auto-negotiation has established a connection at the higher of two rates. The auto-negotiation function follows the establishment of a link (stage 61) and comprises initially a determination whether the specific port supports data transmission at each of at least two rates (stage 62). If the port does not support data transmission at least two rates, then stage 63 indicates that the present invention cannot apply and the programme will not be implemented.

If however the port does support transmission at at least two rates, an enquiry is made (stage 64) whether the end station also supports data transmission at each of at least two rates. Obviously, if the end station does not do so, then the present invention will not apply and data

will be transmitted at whatever rate the end station can support.

If the end station supports data transmission at both rates then, the process of auto-negotiation will result in the selection of the higher of the two rates (not specifically shown in Figure 6). Thereafter the transmission of data between the stations is monitored to detect the occurrences of falsecarrier. The error rate is counted and compared with a threshold (stage 65). This is preferably done repeatedly, as shown in loop 66, throughout the maintenance of the data connection between the hub and the end station. Should the error rate exceed the threshold, then the data processing means produces a command forcing the speed of the port to 10 megabits per second, as shown by stage 67.

As indicated previously, the invention may be extended to a port capable of supporting three or more data rates so that if a operation at a given data rate produces an error rate exceeding a respective threshold the data rate determined for the port is downgraded to the next lower data rate and so on.

CLAIMS

1. A method of controlling the rate of transmission of data between a network hub having various ports and another station connected by way of a transmission link to one of said ports, wherein both the hub and the other station are capable of receiving and transmitting data at any one of a defined plurality of standard data rates, said data rates comprising at least a higher rate and a lower rate, and wherein the hub includes means for establishing by means of auto-negotiation whether data is to be transmitted between the hub and the other station at the said higher rate, and further wherein a data connection between the hub and the other station is maintained by the transmission of a continuous sequence of symbols representing an idle state, said method comprising:

(a) monitoring at the hub the occurrence of an error represented by a symbol other than an idle state immediately followed by an idle state symbol;

(b) comparing a rate of occurrence of said errors with a threshold; and

(c) forcing the data connection to proceed at the said lower rate if the aforementioned error rate exceeds the threshold.

2. A method according to claim 1 wherein a data packet transmitted from the said other station to the hub commences with a first predetermined symbol followed by a second predetermined symbol and wherein said hub detects said errors by detecting the occurrence of said first predetermined symbol immediately followed by a symbol representing the idle state.

The Patent Office

Application No:	GB 9810810.3	**Examiner:**	Gareth Griffiths
Claims searched:	All	**Date of search:**	12 November 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4P (PEM, PEV)

Int Cl (Ed.6): H04L 1/00, 1/12, 1/16

Other: Online Database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB2277237 A	(MITSUBISHI)	
A	US5524122	(LEPITRE)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.